

# Restoration of Natural Forest Ecosystems: The Genetic Resource

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Restoration of many forest ecosystems will require replanting of native species. Choosing the proper seed source is essential to ensure long-term success of restoration plantings, especially if local seed sources are unavailable or genetically degraded. A successful restoration requires seed sources that are adapted to the climate and site, and are genetically diverse to allow subsequent reproduction and adaptation.

Geographic variation in growth and adaptability has been found in every wide-ranging species that has been examined. This variation must be considered in choosing seed sources. Within-species variation is most commonly related to temperatures or moisture availability at the seed source. Geographic variation is not always predictable, however.

## Geographic Variation in the Southern Pines

In the southern pines (*Pinus* subsect. AUSTRALES Loud.), natural distributions are limited to the north by low temperatures, and to the west by moisture availability. Two related southern pine species longleaf (*P. palustris* Mill.) and loblolly (*P. taeda* L.) pines have similar distributions in the southeastern United States but have different patterns of geographic variation. In both species, north/south variation in adaptive traits is related to mean yearly minimum temperatures at the seed source. Minimum temperature is an important limit to seed transfer (Schmidtling 2001), and is used, not coincidentally, by horticulturalists to define planting zones (USDA 1990). Within limits, transfer of seed sources northward will result in greater growth than local sources, but transfer too far north results in cold damage and reduced growth compared to local sources. Southward transfer results in reduced growth compared to local sources.

These two species occur on both sides of the Mississippi River Valley. The natural vegetation in the Valley is hardwood forest, and is devoid of pines. The distance between eastern and western pines across the Valley is considered a barrier to gene flow. Loblolly pine has strong east/west variation across the Mississippi River Valley. Western sources are more drought tolerant and resistant to disease but are slower growing than eastern sources. Seed transfers from west to east may result in slower growth but is low-risk. Transfer from east to west may result in large gains in growth, but there is a risk of catastrophic loss during droughty years (Schmidtling 2002).

East/west variation in longleaf pine, on the other hand, is almost non-existent. Only minimum temperatures at the source need be considered in transferring longleaf pine.

The difference between these two species is probably rooted in the Pleistocene (Schmidtling et al. 1999). There is convincing genetic evidence that during the last ice age, longleaf pine existed in one refugium, in the west, in south Texas or northern Mexico. Loblolly pine, on the other hand, existed in the western refugium plus a refugium in the east, in south Florida or the Caribbean islands. At the close of the Pleistocene, about 14,000 years ago, these populations migrated north with the retreat of the ice. The western longleaf population expanded to cover its present range. The two loblolly populations met somewhere near the Mississippi River. The 100,000-year separation of the two loblolly populations resulted in the differences we see today.

## Conclusions

The difference between these two species is important. There is now underway an extensive program in restoration of the longleaf pine ecosystem in the southeastern United States. None of the southern pines are threatened or endangered, but longleaf pine has been placed on a list of vulnerable species (Farjon and Page 1999), because less than 20% of the original longleaf forest remains.

After years of being replaced with species that were easier to plant, such as loblolly pine, longleaf pine is now being planted in substantial numbers, resulting in a shortage of planting stock. Fortunately, seed source requirements are less stringent due to the lack of east-west variation.

## Literature Cited

- Farjon, A. ; Page, C. N. (Compilers). (1999).  
Conifers: Status survey and conservation action plan. IUCN/SSC  
Conifer Specialist Group. IUCN, Gland, Switzerland and Cambridge,  
UK. ix+ 121 pp.
- Schmidtling, R.C. (2001).  
Southern pine seed sources. Gen. Tech. Rep. SRS-44. Asheville, NC:  
USDA For. Serv., SRS. 25p.
- Schmidtling, R.C.; Carroll, E.; LaFarge, T. (1999).  
allozyme diversity of selected and natural loblolly pine populations.  
*Silvae Genetica* 48: 35-45.
- USDA. (1990):  
USDA Plant hardiness zone map. USDA-Agricultural Research  
Service Misc. Pub. 1475.



Skov & Landskab

# *Proceedings of the IUFRO Conference on Restoration of Boreal and Temperate Forests*

*Documenting Forest Restoration Knowledge and  
Practices in Boreal and Temperate Ecosystems*

*Compiled by: Emile S. Gardiner and Lynne J. Breland*

# Preface

Forestry research and management has undergone profound change in many countries over the last decade. Following the United Nations Conference on Environment and Development in Rio de Janeiro, 1992, national commitments to sustainable forest ecosystems have transformed the way professionals and the public view forest management. On the 10<sup>th</sup> anniversary of the Rio Conference, researchers and managers came together in Vejle, Denmark to identify general approaches, appreciate regional differences, and explore common challenges for restoring forest ecosystems.

The objective of this conference was to document forest restoration knowledge and practice in boreal and temperate ecosystems. Under the auspices of the International Union of Forestry Research Organizations (IUFRO), the conference was organized by the Working Parties on Restoration of Boreal and Temperate Forests (WP 1.17.02) and Temperate Forest Regeneration (WP 1.05.08). The Danish Forest and Landscape Research Institute, the United States Department of Agriculture Forest Service, and the Southern Swedish Forest Research Centre graciously provided sponsorship.

Viewing forest restoration broadly, the organizers emphasized summarizing the entire range of restoration activities at regional and local scales. Invited presentations set the tone by documenting and comparing restoration in specific regions of the temperate and boreal zones. Volunteer oral and poster presentations by speakers from 20 countries established the broad scope of the conference to include (1) Techniques for restoration and rehabilitation of forests (including afforestation, vegetation conversions, natural and artificial regeneration techniques); (2) Effects at stand and landscape levels of forest restoration, especially on biodiversity, wildlife, aquatic systems, and on land-use; (3) Understanding processes and changes in process levels during forest restoration; and (4) Economic and political impacts of forest restoration, including landowner participation, impacts on local communities, and the role of government in restoration programs.

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Conifer Specialist Group. IUCN, Gland. Switzerland and Cambridge,  
UK. ix+ 121 pp.
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Southern pine seed sources. Gen. Tech. Rep. SRS-44. Asheville, NC:  
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allozyme diversity of selected and natural loblolly pine populations.  
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